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A SYSTEMATIC FRAMEWORK OF IT-ENABLED SERVICE RESEARCH TOWARDS FORMULATING RESEARCH QUESTIONS IN IS REALM

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Abstracts

In the past few years service computing has been gradually shaping a new Information Technology (IT) branch and shifting conventional paradigms of business practices and research. Such a transformation involving both technology and management issues, is triggering a hot discussion in the Information Systems (IS) community. Currently, however, little research is available to explore and identify the topics related to service research that IS researchers can undertake. As such, this paper proposes a systematic framework of IT-enabled service research with the purpose of discovering in what scenarios IS researchers can be involved. The developed framework, represented by a hierarchical model along with a relational model, is systematically derived from extant MIS literature using General System Theory (GST). In addition, how to deploy this framework in actual research is discussed from the perspective of formulating research questions. Validation of the framework is achieved by mapping the extant literature into the framework.

Keywords: Service computing, Service management, IT-enabled service, Systems approach, Hierarchical model, Relational model, Research question

1. INTRODUCTION

Since re-emphasized by IBM in 2002, service science has experienced a remarkable emergence and gradually become trans-disciplinary with such areas as computer science, social and cognitive science, marketing and operational research etc. Meanwhile, the service sector has penetrated into a large number of industries (Tien 2008). In particular, service computing and service management (Vargo & Lusch 2004), as the kernel point of service science, have evolved into integral parts of most IT corporations. Service computing refers to "an emerging area of computing science and engineering that includes a collection of techniques (e.g. Web services, service-oriented architecture (SOA)) and the associated computational techniques (e.g. security, service choreography) (Zhao et al. 2008b). It brings about radical change to everyday work of conventional business. Service management is a process-oriented approach that focuses on the delivery and support of quality IT services through planning computing strategies, constructing information infrastructure, allocating computing resources and maintaining computing functions (Clacy & Jennings 2008; Zhao et al. 2008b). Accordingly, various issues are arising from the linkage of people, technology, and organization. How to deal with those issues from both technical aspects (service computing) and managerial aspects (service management) has become a critical task.

A unified framework that can bridge the gap between service computing and service management is required (IBM Research 2004; Zhao et al. 2008b). It is commonly acknowledged that since its inception, the MIS discipline has been amalgamating technology and management and has achieved great success. Hence, in terms of the formulation and development of MIS, it is natural and well-founded for IS researchers to pioneer a bridge to connect service computing and service management. Actually, some researchers (Zhao et al. 2008b) believe that the IS discipline could take a leadership role in building such a bridge. Therefore, we seek to address the following two essential research questions in this study:

- The first question is: "*What should be the spectrum of IT-enabled service research in IS discipline*?". Since this question has not been clearly addressed, it is wise to develop a systematic framework to offer a clear picture of IT-enabled service research. Hence, the system approach is deployed and meantime some prior MIS frameworks and models are incorporated.
- The second research question is: "*How to formulate significant research questions on IT-enabled service research for IS researchers*?". The systematic framework can provide a comprehensive understanding of the service research in IS field. We also claim, however, that how to identify and generate research questions based on the framework also deserves clarification. As a matter of fact, the way to formulate research questions may mean more to most IS pursuers.

Prior to proceeding with this paper, it is necessary to stress that in this study, we focus on service research related to the IS discipline. To differentiate service research related to the IS discipline from general service research, hereafter, we use the term "IT-enabled service" instead.

The remainder of this paper is structured as follows. The next section discusses relevant research with respect to general service systems. Section 3 describes the theoretical foundation, i.e. the systems approach, and develops a systematic framework for IT-enabled service research. This framework provides a starting point to formulate significant research questions for IS discipline. Subsequently, we validate our developed framework through categorizing the extant literature. In Section 5, we conclude the study and point out possible directions of future research.

2. PRIOR WORK

Currently, there is little literature available that develops a comprehensive framework for IT-enabled service research in the IS discipline. From the extant literature, only two studies (Zhao et al. 2008b; Tien 2008) are relevant to discussing the scope of the service research in IS field. Zhao et al.'s (2008b) work is concerned more about the discipline level, i.e. how to build a new realm, especially termed with 'service orientation', then to bridge the gap between service computing and service management. They achieve such a goal by making out the conceptual clarity between service computing and service

management. More specially, they try to examine the idea of service orientation in the triangle of people, software, and organization, illustrated by Figure 1. They identify six relationships in total, three within each single group and three between any two groups. It is explicit that service computing primarily fits with the relationships involving software components, while service management primarily fits with the relationships involving people. Zhao et al. also claim it is possible to unify some of the concepts between service computing and service management as they both involve people and software. Although Figure 1 is relatively simple, it offers us a clear picture of the linkage between service computing and service management.

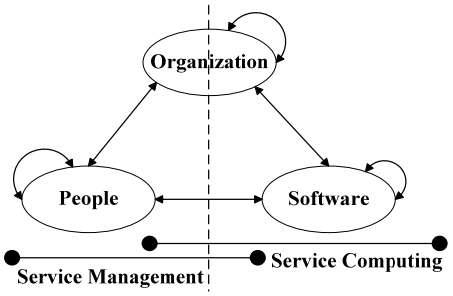

Figure 1. An illustration of service orientation (adapted from Zhao et al. 2008b).

The other relevant work is Tien's (2008). Tien provides a systematic perspective on general service system in multifarious service sectors (such as manufacturing, construction, agriculture) in various industries, ranging from healthcare, education to government, finance etc. In general, Tien contends that a common service system is composed of three essential components: people (characterized by behaviors, attitudes, values etc.), process (characterized by collaboration, customization etc.) and products (characterized by software, hardware, infrastructure etc.), shown by Table 1. He also describes an integrative method for service system integration from the perspective of System-of-System (SoS).

System Sub-Components	**System Components (Elements)**		
	People (Behaviors, Attitudes, Values, Etc.)	**Process** (Collaboration, Customization etc.)	**Products** (Software, Hardware, Infrastructures, etc.)
Demand	Customers, Users, Consumers, Buyers, Organizations, Etc.		
Supply	Suppliers, Providers, Servers, Sellers, Organizations, Etc.		
Procedural		Standards, Evolving, Decision-Focused, Network-Oriented, Etc.	
Algorithmic		Data Mining, Decision Modeling, Systems Engineering, Etc.	
Physical			Facilities, Sensors, Information Technologies Etc.
Virtual			E-Commerce, Second Life, Simulations, E-Collaboration, Etc.

Table 1. Service system: components and subcomponents (adapted from Tien 2008).

Through the two aforementioned studies, it is obvious that Zhao et al. provide a vivid picture on the gap between service computing and service management, viz. conceptual clarity on the discipline level, while Tien presents a systematic view on general service system, viz. generic description on all fields involving service. Therefore, in terms of the extant literature, little research has been done regarding IT-enabled research within the IS discipline. Furthermore, it is critical to pinpoint that, like Nolan and Wetherbe (1980)'s view, the goal of this study is not to propose a framework to substitute the prior ones, such as Zhao et al. (2008b), Tien (2008), but rather to provide a comprehensive understanding of the scope of service research in the IS discipline.

3. A SYSTEMATIC FRAMEWORK OF IT-ENABLED SERVICE RESEARCH

In this section, we adopt the systems approach together with some MIS literature to analyze the components involved in the IT-enabled service research thereby developing a three-level hierarchical model. Then from this hierarchical model, a relational model is derived, that establishes the fundamentals to generate reasonable research questions.

3.1 Systems Approach

The systems theory, firstly proposed by von Bertalanffy (1950), furnishes a basis to describe and understand the real world in the light of systems that consist of interacting elements. It makes it possible to capture, explain and predict the knowledge at different levels of abstraction in a certain segment of the world (Matook & Brown 2008). Much extant literature (Nolan & Wetherbe 1980; Garrity 2001; Moral et al. 2007; Matook & Brown 2008) has adopted systems approach to deal with complex systems. A service system is a complex system that is a function of the number and variety of people, technologies, and organizations linked in the value creation networks (Maglio et al. 2006). Moreover, some researchers (Boulding 1956; Nolan & Wetherbe 1980) argue that the systems approach is appropriate for developing systematic frameworks for describing general relationships in the empirical world. Therefore, we introduce the systems approach to develop the IT-enabled service research framework.

The fundamental premise of systems theory or the systems approach is that systems, regardless of their specific context, share a common set of elements (Churchman 1968; Gad & Michael 1985), illustrated by Figure 2: *environment*, *role or function*, *component*, *arrangement* and *resources*, i.e. *S*= (*N*, *R*, *F*, *E*, *Re*).

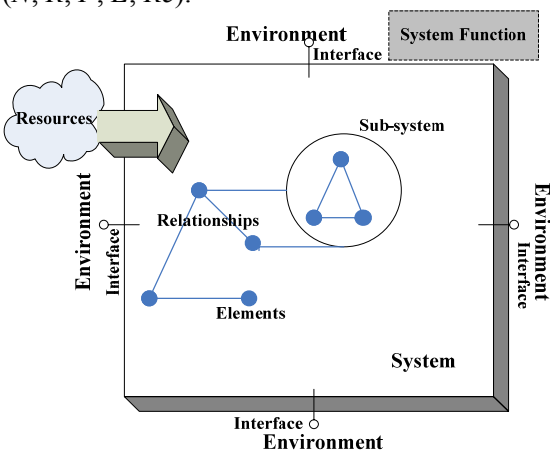

Figure 2. An illustration of general system theory

- *N*. The *components* of the system are the identifiable elements within the system boundary. These components represent the functional building blocks of the system. Two common bases for component definition are division of labor and specialization by environmental segment. The former relates to the ability to perform effectively a particular, necessary task, while the latter relates to the ability to interface with a particular aspect of the environment;
- *R*. The *arrangements* concern the links among the system components and between them and the environmental elements. The fundamental concern in arranging components is the balance between coordination autonomy. Generally it is preferable to minimize the interdependence among components, while still allowing the system as a whole to serve its function. The two key dimensions of arrangement are the configuration or layout of the links among components, and the nature of these links;
- *F*. The *function*, or *role* of a system represents its intended impact on its environment. It specifies which services the system is supposed to deliver and what its goals are. It also provides the basis for evaluating the system and thus should be specified in terms that are amenable to measurement;

- *E*. The *environment* is the set of entities and conditions outside of the system boundary that affects the system or is affected by it. Each system problem does not exist on its own, but is inextricably tied to its environment (Churchman 1979). The entities in the environment may be affected by the system, but are not controlled by it;
- *Re*. The system *resources* are the elements that used or consumed in building and operating the system. Like the environment, resources exist outside the boundary. Resources are differentiated from the environment in that they are partially controllable. They may include people, raw materials, capital, tools, and techniques, etc.

3.2 The Framework of IT-Enabled Service Research

As a matter of fact, *system*, *environmen*t and *resources* are all relative concepts, rather than absolute ones. They might interconvert upon the different focuses of actual research. In other words, in some case, the *environment* may play a role of *system*, while the original *system* may become its *environment*. For instance, considering a web-based service context, a system developer may primarily focus on the design and development of *web-based service system* and *the users* belong to the environment of *web-based service system*; on the contrary, a business manager may be concerned more about *the users*' attitude to their provided services. In this regard, the *web-based service system* becomes the environment of *the users*. Hence, in this study, we will mainly focus on the scope, i.e. the set of *elements*, and the *relationships* between elements, of the IT-enabled service research. That means we do not distinguish the elements that exactly belong to the IT-enabled service system or the elements that pertain to its environment or resources since those vary or exchange on distinct actual situations. In addition, different IT-enabled service systems may play different roles. We will not examine the functions of different IT-enabled service systems in our framework below. Instead, we use a common description of system functions for the IT-enabled service framework: service systems are value-creation networks composed of people, technology, and the organization (Maglio 2006).

3.2.1 Component Analysis: A Hierarchical Model with Three Distinct Levels

As we intend to develop an IT-enabled service research framework for IS discipline, the first step is to identify the components from the scope of the traditional IS discipline. Many textbooks and early literature discuss the key components involved in IS field. Especially, this study selects those key elements in IS identified by Silver et al.'s (1995). Silver et al. present a relatively comprehensive identification of the key elements from IS-centered view and managerial view respectively, shown by Figure 3. By combining those two views of IS, we can identify six critical elements, viz. data, hardware, software, people, procedure and business processes. These elements are as the starting point, viz. macro-level, to derive specific components in IT-enabled service system.

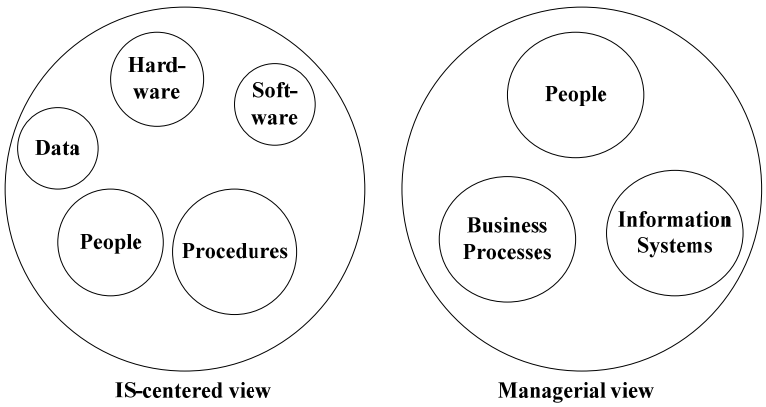

Figure 3. IS-centered vs. managerial view of IS.

Currently, little relevant literature regarding IT-enabled service research is available in the IS realm. As such it is impossible to elicit a comprehensive identification of key components of IT-enabled

service through literature review. However, luckily, Zhang[1] (2008) summarizes a multi-level structure of the body of knowledge areas of service computing. Zhang's summary of the body of knowledge areas in service computing is relatively authoritative thereby providing a strong foundation for our component analysis. In his study, Zhang categorizes the service computing discipline into 4 categories: services and services systems, services technologies, services consulting and deliveries, and services solutioning and management. These can be further classified into 14 subcategories: *principle of services (M1), services lifecycle (M2), Web services (M3), service-oriented architecture (M4), services relationships (M5), services composition (M6), business process management & integration (M7), business grid and cloud computing (M8), enterprise modeling and management (M9), service-oriented consulting methodology (M10), services delivery platform and methodology (M11), application services and standards (M12), security, privacy, and trust in services (M13)* and *IT services management (M14)*. By mapping those categories and their specific subcategories into the key components in the aforementioned macro-level and common knowledge (e.g. data type and knowledge representation) within IS discipline, we can gain the meso-level and micro-level components for IT-enabled research. In addition, some components are refined according to literature review. For example, "IT service demander" is deployed to represent all kinds of IT service users. The entire components' framework is illustrated by Figure 4.

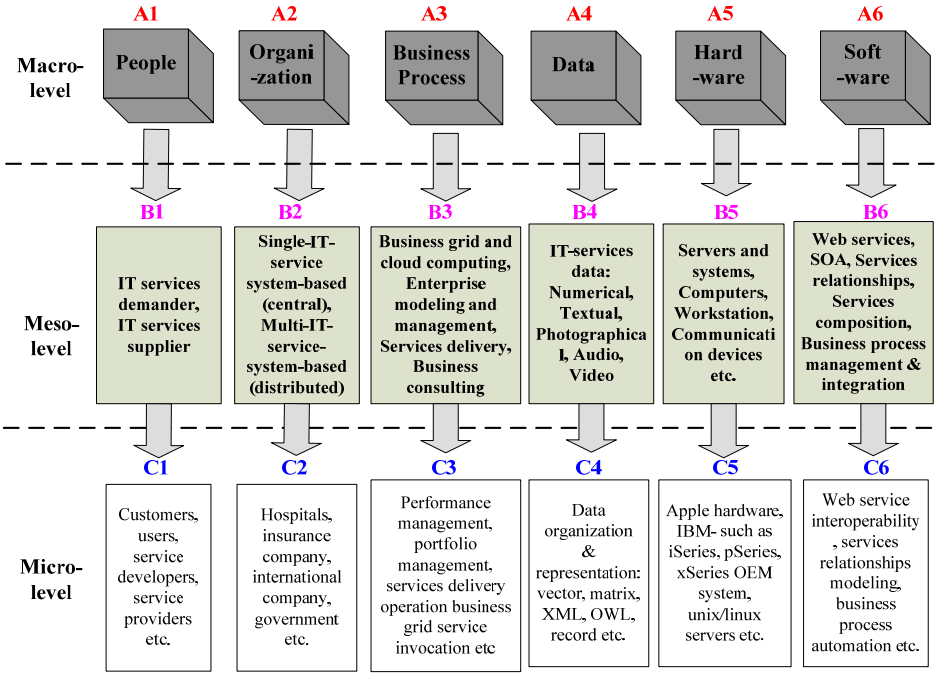

Figure 4. Hierarchical model of components in IT-enabled service research

3.2.2 Relationship analysis

From the perspective of systems theory, researchers might examine in some depth a single variable from any of the groups, or examine relationships among variables (Ives et al. 1980). According to the three kinds of entities in the system theory, viz. *environment*, *resources* and *system*, we develop a relational model, illustrated with a Venn diagram (see by Figure 5), to examine the potential relationships among variables.

[1] Zhang is a research staff and also a lead researcher and architect of service research at IBM T. J. Watson Research Center, where service computing was firstly proposed.

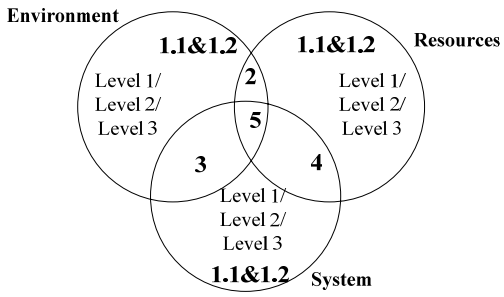

Figure 5. Relational Model of IT-Enabled Service Research

Figure 5 illustrates that five sorts of relationships can be identified from the systematic view. Type 1.1 represents the properties of one component, and Type 1.2 represents the relationship of components in a single variable group—system, environment or resources. Type 2 examines the relationship between one or more components from the environment group and the resource group. Likewise, Type 3 and Type 4 discuss the relationship between one or more components from the environment group and the system group, and the system group and the resource group respectively. Finally, Type 5 denotes the relationship between one more components from all the three groups.

4. FORMULATING RESEARCH QUESTIONS: ONE POTENTIAL ROLE OF IT-ENABLED SERVICE RESEARCH FRAMEWORKS

Any scientific field should involve a systematic body of knowledge or practice with rules by which one deals with and develops new knowledge. Formulating grounded research questions, as a fundamental to develop a field towards a scientific view, should attract more attention. Therefore, in this section, we seek to offer a preliminary scenario on how to formulate reasonable research questions for service research, especially in the IS field through our proposed IT-enabled service research framework.

Generally, two fundamental approaches are available to generate research questions. One approach is traditionally termed as 'gap-spotting' (Locke & Golden-Biddle 1997). Locke & Golden-Biddle conducted an empirical survey of 82 qualitative studies published in Administrative Science Quarterly and Academy of Management Journal between 1976 and 1996. The kernel judgment towards identifying opportunities involved in their study was to criticize the extant literature for lacking something significant, viz. try to ascertain some significant gaps in the literature. The second branch is to use the problematization methodology (Alvesson & Sanderberg 2008) as a means to identify, articulate and challenge the assumptions underlying existing literature about a subject matter and thereby enabling formulating research questions. Specially, in this paper, considering the limit of the relevant literature, we will adopt the 'gap-spotting' approach to identify the substantially meaningful gaps and further to generate appropriate research questions.

Furthermore, based on the well-formalized ontology theory proposed and discussed by Bunge (1977) and some IS researchers (e.g. Wand & Weber 1990; Weber 1997; Shanks et al. 2008), some essential arguments could be derived below:

- The world is made of things that possess properties. Things and properties are two fundamental constructs used to describe the world;
- Every thing in the world holds one or more properties;
- Basically, a property can be intrinsic property or mutual property, which builds upon one thing only and two or more things respectively. A mutual property between two things shows that they interact with each other ;
- Humans do not necessarily observe properties directly, but instead assign attributes to things (Gemino & Wand 2005).

Therefore, to formulate research questions, we claim the following two natural propositions:

Proposition 1:

People primarily observe the properties when they try to understand a thing or a system in the real world.

Proposition 2:

The properties of a thing are exhibited by its intrinsic property, while the properties between or among things are exhibited by their mutual properties.

Regarding the intrinsic properties in proposition 2, it corresponds to Type 1.1 relationships in Figure 5. In other words, the relationship indicates the property of the single element. With respect to the mutual properties in proposition 2, it corresponds to the other relationships in Figure 5, viz. Type 1.2 and Type 2-5. For example, for the technology component "Web services", its intrinsic properties include its effectiveness, efficiency etc, while its mutual properties refer to its impact on business processing modeling etc.

According to the above discussions, we develop a six-step guideline to formulate research questions:

Step 1: In terms of the research purpose, confirm the primary research theme;
Step 2: Based on the macro- and meso-level of developed hierarchical model, identify the primary components related to the confirmed theme thereby identifying the system, its environment, and its resources;
Step 3: With the guidance of the micro-level of developed hierarchical model, further divide and identify the subcomponents;
Step 4: Analyze the distinct relationships between or among components in terms of the developed relational model.
Step 5: Identify the intrinsic properties and mutual properties for each component;
Step 6: In the light of the acquired results (identified components, intrinsic properties and mutual properties), researchers can finalize their research questions in terms of their actual purpose.

5. EVALUATION: CATEGORIZATION EXISTING LITERATURE

The proposed service research framework can be evaluated through its capability to posit the extant literature (Ives et al. 1980; Nolan 1980). In particular, the intrinsic properties and mutual properties are examined to show the feasibility of the proposed guidelines for formulating research questions. Since our proposed framework is primarily intended to provide guidance for service research, especially in IS field, we select three IS journals, each of which includes a recent special issue on service research. The three journals were IEEE Transactions on Service Computing (Vol. 1-3, No. 2, 2009), Information Systems Frontier (Vol. 9, 2007) and ACM Transactions on the Web (Vol. 2, No. 2, 2008). In total, 20 papers were collected. Following the procedures deployed by Nolan & Wetherbe (1980), a straightforward approach focusing on the abstract of each article to identify the key issues is adopted.

For example, consider the paper "*Guided interaction: A mechanism to enable ad hoc service interaction*" by Oaks and Hofstede (2007),

> "*Ad hoc interaction between web services and their clients is a worthwhile but seemingly distant goal. At present, most of the interest in web services is focused on pre-planned B2B interaction. Clients interact with services using advance knowledge of the data and sequence requirements of the service and pre-programmed calls to their interfaces. This type of interaction cannot be used for ad hoc interaction between services and their clients such as mobile devices moving in and around rich dynamic environments because clients may not have the necessary knowledge in advance. For unplanned ad hoc interaction an interaction mechanism is required that does not require clients to have advance knowledge of programmatic service interfaces and interaction sequences. The mechanism must ensure clients with different resources and diverse competencies can successfully interact with newly discovered services by providing assistance such as disambiguation of terminology, alternative types of inputs, and context sensitive error reporting when necessary. This paper introduces a service interaction mechanism called guided interaction. Guided interaction is designed to enable clients without prior knowledge of programmatic interfaces to be assisted to a successful outcome. The mechanism is grounded in core computing primitives and based on a dialogue model. Guided interaction has two parts; the first part is a language for the exchange of information between services and their clients. The second part is a language for services to create interaction plans that allow them to gather the data they require*

from clients in a flexible way with the provision of assistance when necessary. An interpreter uses the plan to generate and interpret messages in the exchange language and to manage the path of the dialogue."

Through reading the abstract, it can be initially determined that this paper is dealing with the interactions between web services and their clients. Therefore, the components "Web services" and "clients" can be extracted. Obviously, "Web services" belongs to the chain "A6-B6-C6" (see Figure 4) and is especially in B6, while "clients" corresponds to the chain "A1-B1-C1" (see Figure 4) and is in B1. Also, the authors of this study concern their relationship termed with "interaction". Apparently, this is mutual property between "Web services" and "clients". So the research question of this article is formalized "Interaction (Mutual Property): Web services (B6) and clients (B1)". Then the point is confirmed through reading the whole article. The results for relating 20 articles collected to the proposed service research framework and formation of research questions are illustrated in the Appendix. All the results demonstrate and authenticate the applicability of the proposed service research framework and guidelines to generate research questions.

6. CONCLUSIONS AND FUTURE DIRECTIONS

The aim of this study is to provide a comprehensive understanding about the spectrum of IT-enabled service research in the IS discipline. Specially, this study primarily contributes to the IS research in two ways: First, a comprehensive IT-enabled service research framework is developed that includes a hierarchical model and a relational model, for IS researchers. This framework is distinct from prior research frameworks that are characterized by abstract components. A systemic view of service research framework can provide guidance for developing a research realm in IS field and can also serve as a basis for formulating grounded research questions towards a scientific view. In addition, the thought of hierarchical model of components regarding IT-enabled service is consistent with that of classification, which is a fundamental human capability encountered in daily life and is essential to human survival and adaptation (Lakoff 1987, p.6; Parsons & Wand 2008). Second, the research provides guidance on how to formulate service-related research questions in the IS discipline. The results demonstrate the feasibility and applicability of the service research framework and guidelines for formulating meaningful research questions.

This study seeks to provide a comprehensive understanding of what service scenarios the IS researchers can now participate, rather than replace the prior ones. As a starting point, it inevitably involves some limitations that also lead to some areas of future research: First, components involved in the frameworks might be incomplete thereby requiring the framework to be extended. With the increasing emergence of academic papers on service research, latent semantic analysis and factor analysis techniques that have been adopted in conventional analysis of IS research (Sidorova et al. 2008; Larsen et al. 2008), can be utilized to provide a more extensive service research framework with specification of various branches in IS field in the future; also due to the length limitation, the specifications of components in the framework are not included. Second, the volume of data for validation might not be sufficient; therefore, requiring collection of additional relevant literature in the future. Third, it would be better to further identify and specify the properties of each component in the proposed hierarchical model to allow for the generation of specific research questions.

References

Ackoff, R. L. (1971) "Towards a system of systems concepts", *Management Science* 17(2), 661-671.

Benbasat, I. and Schroeder, R.G. (1977) "An experimental investigation of some MIS design variables", *MIS Quarterly*, 1(1), 37-49.

Bertalanffy, L. von. (1950) "An Outline of General Systems Theory", *British Journal of the Philosophy of Science*, 1, 134-168.

Boulding, K. (1956) "General systems theory: The skeleton of science", *Management Science*, 2(3), 197-208.

Bunge, M. (1977). *Treatise on Basic Philosophy: Volume 3: Ontology I: The Furniture of the World*, Boston: Reidel.

Churchman, C.W. (1968) *The System Approach*. Dell, New York.

Churchman, C.W. (1979) *The Systems Approach and Its Enemies*. New York, NY: Basic Books, Inc.
Clacy, B. and Jennings, B. (2008) "Service Management: Driving the Future of IT", *Computer*, 40(5), 98-100.
Davis, G. and Jensen, J. (1974) *Instructor's Manual to Accompany Management Information Systems Conceptual Foundations, Structure, Development*, McGraw-Hill Book Co., New York, New York.
Gad, A., and Michael, J.G. (1985) "DSS design: A systemic view of decision support", *Journal of Communications of the ACM*, 28 (10), 1045-1052.
Garrity, E.J. (2001) "Synthesizing user centered and designer centered IS development approaches using general systems theory", *Information Systems Frontiers*, 3(1), 107-121.
Gemino, A. and Wand, Y. (2005). "Complexity and clarity in conceptual modeling: Comparison of mandatory and optional properties", *Data & Knowledge Engineering,* 55, 301-326.
Hevner, A.R., March, S.T., Park, J. and Ram, S. (2004) "Design science in information systems research", *MIS Quarterly*, 28(1), 75-105.
IBM Research (2004) "*Service Science: A New Academic Discipline?*" A 120-page of a two-day summit entitled Architecture of On-Demand Business, May 17-18.
Ives, B., Hamilton, S. and Davis, G.B. (1980) "A framework for research in computer-based management information systems", *Management Science*, 26 (9), 910-935.
Lakoff, G. (1987) *Women, Fire, and Dangerous Things: What categories Reveal About the Mind*, Chicago: University of Chicago Press.
Larsen, K., Monarchi, D., Hovorka, D., and Bailey, C. "Analyzing unstructured test data: using latent categorization to identify intellectual communities in information systems", *Decision Support Science*, 45, 884-896.
Mora, M., Gelman, O., Forgionne, G., Petkov, D. And Cano, J. (2007) "Integrating the fragmented pieces of IS research paradigms and frameworks: A system approach", *Information Resource Management Journal*, 20(2), 1-22.
Nolan, R. L. and Wetherbe, J. C. (1980) "Toward a comprehensive framework for MIS research", *MIS Quarterly*, 4(2), 1-20.
Maglio, P. P., Srinivasan, S., Kreulen, J. T. and Spohrer, J. (2006) "Service systems, service scientists, SSME, and innovation", *Communications of the ACM*, 49(7), 81-85.
Matook, S. and Brown, S.A. (2008) "Conceptualizing the IT artifact for MIS research", In the *Proceeding of 29th International Conference on Information Systems*, Paris.
Oaks, P. and Hofstede, A. (2007) "Guided interaction: A mechanism to enable ad hoc service interaction", *Information Systems Frontier*, 9(1), 29-51.
Shanks, G., Tansley, E., Nuredini, J., Tobin, D. and Weber, R. (2008) "Representing part-Whole relations in conceptual modeling: An empirical evaluation", MIS Quarterly, 32(3), 553-573.
Sidorova, A., Evangelopoulos, N., Valacich, J., and Ramakrishnan, T. (2008) "Uncovering the intellectual core of the information systems discipline", *MIS Quarterly*, 32(3), 467-482.
Tien, J. M. (2008) "Services: A system's perspective", *IEEE Systems Journal*, 2(1), 146-157.
Vargo, S. L. and Lusch, R. F. (2004) "Evolving to a new dominant logic for marketing", *Journal of Marketing*, 68, 1-17.
Wand, Y. and Weber, R. (1990) "An ontological model of an information system", *IEEE Trans. Software Eng.,* 16(11), 1281-1291.
Weber, R. 1997. *Ontological Foundations of Information Systems*, Coopers & Lybrand Accounting Research Methodology, Monograph No. 4, Melbourne.
Zhang, L. J. (2008) "EIC editorial: Introduction to the body of knowledge areas of services computing", *IEEE Transactions on Services Computing*, 1(2), 62-74.
Zhao, J. L., Goul, M., Purao, S., Vitharana, P. and Wang, H. J. (2008a) "Impact of service-centric computing on business and education", *Communications of the Association for Information Systems, 22*, 295-310.
Zhao, J. L., Hsu, C., Jain, H. K., Spohrer, J. C., Tanniru, M. And Wang, H. J. (2008b) "ICIS 2007 panel report: bridging service computing and service management: How MIS contributes to service orientation", *Communications of the Association for Information Systems*, 22, 413-428.
Zhao, J. L., Tanniru, M. and Zhang, L. J. (2007) "Services computing as the foundation of enterprise agility: Overview of recent advances and introduction to the special issue", *Information Systems Frontier*, 9, 1-8.

Appendix

NB: In the last column of the table below, *f* |-> *x* indicates an intrinsic property of *x* or a mutual property among *x*(s), while *f* |-> *x* <*y* indicates a mutual property between/among *x*(s) and *y*(s).

Articles Examined	Components		Relations		Formalization of research questions
	Identification	*Corresponding Chain in the Service Framework*	*Intrinsic Properties*	*Mutual Properties*	
1. Madhusudan, T. (2007) "A web services framework for distributed model management", *Information Systems Frontier*, 9(1), 9-27.	Web Services (B6), Service Planning and Execution (C3)	A3-B3-C3, A6-B6-C6	–	√	Framework (Mutual Property) |-> Web services (B6) ∧ Service Planning and Execution (C3)
2. Oaks, P. and Hofstede, A. (2007) "Guided interaction: A mechanism to enable ad hoc service interaction", *Information Systems Frontier*, 9(1), 29-51.	Web Service (B6), Clients (B1)	A6-B6-C6, A1-B1-C1	–	√	Interaction (Mutual Property) |-> Web Services (B6) ∧ Clients (B1)
3. Gosain, S. (2007) "Realizing the vision for web services: Strategies for dealing with imperfect standards", *Information Systems Frontier*, 9(1), 53-67.	Web Service (B6)	A6-B6-C6	√	√	Framework (Mutual Property) |-> (Imperfect Standards (Intrinsic Property) |-> Web Services (B6))
4. Bell, D. et al. (2007) "A framework for deriving semantic web services", *Information Systems Frontiers*, 9(1), 69-84.	Web Service (B6)	A6-B6-C6	–	√	Framework (Mutual Property) |-> Web Services (B6)
5. Patrick, C.K. et al. (2007) "End-to-end privacy control in service outsourcing of human intensive processes: A multi-layered web service integration approach", *Information Systems Frontier*, 9(1), 85-101.	Services (B6), Customers (C1)	A1-B1-C1, A6-B6-C6	–	√	Privacy Control (Mutual Property) |-> (Services(B6) ∧ Customers (C1))
6. Rhee, S.H., Bae, H., and Choi, Y. (2007) "Enhancing the efficiency of supply chain processes through web service", *Information Systems Frontier*, 9(1), 103-118.	Supply Chain Process (C3), Web Service (B6)	A3-B3-C3 A6-B6-C6	√	–	Efficiency (Intrinsic Property) |-> Supply Chain Process (C3) with Web Service (B6)
7. Umapathy, K. and Purao, S. (2007) "A theoretical investigation of the emerging standards for web service", *Information Systems Frontier*, 9(1), 119-134.	Web Service (B6)	A6-B6-C6	√	–	Standards (Intrinsic Property) |-> Web Services (B6)
8. Barker, A., Walton, C.D. and Robertson, D. (2009) "Choreographing web services", *IEEE Transactions on Services Computing*, 2(2), 152-166.	Web Service (B6)	A6-B6-C6	–	√	Choreograph (Mutual Property) |-> Web Services (B6)
9. Zheng, G. and Bouguettaya, A. (2009) "Service mining on the Web", *IEEE Transactions on Services Computing*, 2(1), 65-78.	Web Service (B6)	A6-B6-C6	–	√	Mining Framework (Mutual Property) |-> Web Services (B6)
10. Kohlborn, T. and Korthaus, A. (2009) "Identification and analysis of business and software services: A	Services (B6)	A6-B6-C6	√	√	Identification and Analysis (Intrinsic Property & Mutual Property) |-> Services (B6)

consolidated approach", *IEEE Transactions on Services Computing*, 2(1), 50-64.					
11. Liang, Q.H (2009) "Optimizing service systems based on application-level QoS", *IEEE Transactions on Services Computing*, 2(2), 108-121.	Service Systems (C6)	A6-B6-C6	–	√	Optimization (Mutual Property) |-> Service systems (C6)
12. Lin, C. et al. (2009) "A reference architecture for scientific workflow management systems and the view SOA solution", *IEEE Transactions on Services Computing*, 2(1). 79-92.	Workflow Management (B3)	A3-B3-C3	–	√	Reference Architecture (Mutual Property) |-> Workflow Management (B3)
13. Kim, H.K, Kim, J.K. and Ryu, Y.U. (2009) "Personalized recommendation over customer network for ubiquitous shopping", *IEEE Transactions on Services Computing*, 2(2), 140-151.	(Personalized) Services (B6)	A6-B6-C6	–	√	Recommendation (Mutual Property) |-> (Personalized) Services (B6)
14. Liu, X.L. (2009) "Discovering homogeneous web service community in the user-centric web environment", *IEEE Transactions on Services Computing*, 2(2), 167-181.	Web Service (B6), User (C1)	A6-B6-C6, A1-B1-C1	–	√	Homogeneous Web Service Discovery (Mutual Property) |-> Web Service (B6) ∧ User (C1)
15. Rosenkrantz, D.J. et al. (2009) "Resilience metrics for service-oriented networks: A service allocation approach", *IEEE Transactions on Services Computing*, 2(3), 183-196.	Services (B6), Services Network (B6)	A6-B6-C6	–	√	Resilience Metrics (Mutual Property) |-> Services Network (B6)
16. Kongdenfha, W. et al. (2009) "Mismatch patterns and adaptation aspects: A foundation for rapid development of web service adapters", *IEEE Transactions on Services Computing*, 2(2), 94-107.	Web Service Adaptation (C6), Protocols (C6), Business Interfaces (C6)	A6-B6-C6	–	√	Mismatch Patterns (Mutual Property) |-> Protocols (C6), Business Interfaces (C6)
17. Belhajjame, K. et al. (2008) "Automatic annotation of web services based on workflow definitions", *ACM Transactions on the Web*, 2(2), Article 11.	Web Service (B6), Web Service Annotation (C6)	A6-B6-C6	√	–	Semantic Annotation (Intrinsic Property) |-> Web Service (B6)
18. Elgedawy, I., Tari, Z. and Thom, J.A. (2008), "Correctness-aware high-level functional matching approaches for semantic web services", *ACM Transactions on the Web*, 2(2), Article 12.	Semantic web Service (B6)	A6-B6-C6	–	√	Mapping (Mutual Property) |-> Semantic Web Service (B6)
19. Ryu, S.H. et al. (2008) "Supporting the dynamic evolution of web service protocols in service-oriented architectures", *ACM Transactions on the Web*, 2(2), Article 13.	Web Service (B6), Service protocols (C6), Service Providers (C6)	A6-B6-C6, A1-B1-C1	–	√	Dynamic evolution (Mutual Property) |-> Service Protocols (C6) ∧ Web Service (B6)
20. Schafer, M., Dolog, P. and Nejdl, W. (2008) "An environment for flexible advanced compensations of web service transactions". *ACM Transactions on the Web*, 2(2), Article 14.	Web Service (B6), Abstract Service (B6), Adapter (C5)	A6-B6-C6, A5-B5-C5	–	√	Compensations (Mutual Property) |-> Web Service (B6) Transactions with (Abstract Service (B6) ∧ Adapter (C5))